CLAIMS

1. A fluid-jet cutting machine, comprising:

a nozzle adapted to be coupled to a high-pressure fluid source and an abrasive particle delivery device, the nozzle being configured to project an abrasive fluid-jet;

a carrier assembly attached to the nozzle to move the nozzle and the fluid-jet along a cutting path;

a tank aligned with the nozzle, the tank including at least one compartment configured to receive the fluid and the abrasive particles of the fluid-jet along at least a portion of the cutting path and to control fluid flow out of the one compartment, the controlled fluid flow of the one compartment and the fluid-jet maintaining at least a substantial portion of the abrasive particles in suspension in the fluid in the one compartment without additional mechanical agitation;

a fluid transport mechanism including a conduit, the conduit having a first end in fluid communication with the one compartment and a second end outside of the one compartment; and

a settling container separate from the one compartment, the second end of the conduit being in fluid communication with the settling container, a portion of the fluid with suspended abrasive particles in the one compartment being transported through the conduit from the one compartment into the settling container, and the abrasive particles from the transported portion of fluid settling to a lower portion of the settling container while a clarified fluid is removed from the settling container through an outlet of the settling container.

2. The fluid-jet cutting machine of claim 1 wherein the first end of the conduit is positioned at a lower portion of the one compartment and the second end of the conduit is positioned below the first end and in the settling container, the

fluid and the abrasive particles suspended in the fluid flowing through the conduit from the one compartment to the settling container under the influence of gravity.

3. The fluid-jet cutting machine of claim 1 wherein the fluid transport mechanism further comprises a fluid drive system coupled to the conduit, the fluid drive system driving fluid and abrasive particles suspended in the fluid through the conduit to the settling container.

4. The fluid-jet cutting machine of claim 3 wherein:

the first end of the conduit is positioned in a lower portion of the one compartment; and

the fluid drive system comprises a pressurized gas source attached to the conduit at a location below a fluid level in the one compartment, a gas from the pressurized gas source being injected into the conduit and the gas rising through at least a portion of the conduit, the rising gas drawing fluid and abrasive particles suspended in the fluid through the conduit from the one compartment to the settling container.

5. The fluid-jet cutting machine of claim 4 wherein the fluid drive system further comprises a back-flush valve in the conduit between the second end and the location of attachment of the pressurized gas source, the back-flush valve being positionable in an open position to allow fluid to flow through the conduit and a closed position to allow pressure to build in the conduit for clearing a blockage of abrasive particles from the first end of the conduit.

6. The fluid-jet cutting machine of claim 1 wherein the tank further includes a plurality of compartments and the cutting path moves with respect to the tank to pass across at least two of the plurality of the compartments, each compartment being configured to receive the fluid and the abrasive particles from the

fluid-jet as the fluid-jet passes across each compartment and to control fluid flow to an adjacent compartment, and, while the fluid-jet passes across one of the compartments, the controlled fluid flow of the one of the compartments and the fluid-jet maintaining at least a substantial portion of the abrasive particles in suspension in the fluid in the one of the compartments without additional mechanical agitation.

7. The fluid-jet cutting machine of claim 6 wherein the tank comprises:

a bottom panel, a first side-wall projecting from one side of the bottom panel, a second side-wall projecting from another side of the bottom panel and juxtaposed to the first side-wall, a first end-wall projecting from one end of the bottom panel, and a second end-wall projecting from another end of the bottom panel and juxtaposed to the first end-wall, the first and second end-walls being attached to the first and second side-walls; and

at least one divider extending across the tank between one of side-walls or the end-walls to divide the tank into at least two compartments.

8. The fluid-jet cutting machine of claim 7 wherein the divider comprises a baffle around which a restricted fluid flow may pass from a first compartment to an adjacent second compartment.

9. The fluid-jet cutting machine of claim 6 wherein:

the tank comprises at least a first compartment and a second compartment;

the conduit comprises at least a first conduit section and a second conduit section, the first conduit section having a first end positioned in a lower portion of the first compartment and a second end positioned in the second compartment, the second conduit section having a first end positioned in a lower portion of the second compartment and located to receive a first fluid flow from the

first conduit section, and the second conduit section further including a second end open to the settling container; and

the fluid transport system further comprises a fluid drive system coupled to the first and second conduit sections, the fluid drive system driving the first fluid flow through the first conduit section from the first compartment to the second compartment, and the fluid drive system driving a second fluid flow through the second conduit section from the second compartment to the settling container.

10. The fluid-jet cutting machine of claim 9 wherein the fluid drive system comprises:

a pressurized gas source; and

a gas line coupled to the gas source, the gas line having a first segment attached to the first conduit section a location below a fluid level in the first compartment, and the gas line having a second segment attached to the second conduit section at a location below a fluid level of the second compartment, a gas from the pressurized gas source being injected into the first and second conduit sections and the gas rising through the conduit sections to draw the first and second fluid flows through the first and second conduit sections, respectively.

11. The fluid-jet cutting machine of claim 10 wherein the fluid drive system further comprises:

a first back-flush valve in the first conduit section between the second end of the first conduit section and the location of attachment of the first gas line, the first back-flush valve being positionable in an open position to allow the first fluid flow through the first conduit section and a closed position to allow pressure to build in the first conduit section for clearing a blockage of abrasive particles from the first end of the first conduit section; and

a second back-flush valve in the second conduit section between the second end of the second conduit section and the location of attachment of the second

gas line, the second back-flush valve being positionable in an open position to allow the second fluid flow through the second conduit section and a closed position to allow pressure to build in the second conduit section for clearing a blockage of abrasive particles from the first end of the second conduit section.

12. An abrasive particle removal device for use with a fluid-jet cutting machine having a nozzle, a high-pressure fluid source and an abrasive particle source coupled to the nozzle to generate a fluid-jet having a fluid and a plurality of abrasive particles, and a carrier assembly attached to the nozzle to move the nozzle along a cutting path, the particle removal device comprising:

a tank aligned with the nozzle, the tank including at least one compartment configured to receive the fluid and the abrasive particles of the fluid-jet along at least a portion of the cutting path and to control fluid flow out of the one compartment, the controlled fluid flow of one compartment and the fluid-jet maintaining at least a substantial portion of the abrasive particles in suspension in the fluid in the one compartment without additional mechanical agitation;

a fluid transport mechanism including a conduit, the conduit having a first end in fluid communication with the one compartment and a second end outside of the one compartment; and

a settling container separate from the one compartment, the second end of the conduit being in fluid communication with the settling container, a portion of the fluid with suspended abrasive particles in the one compartment being transported through the conduit from the one compartment into the settling container, and the abrasive particles from the transported portion of fluid settling to a lower portion of the settling container while a clarified fluid is removed from the settling container through an outlet of the settling container.

13. The removal device of claim 12 wherein the first end of the conduit is positioned at a lower portion of the one compartment and the second end of the conduit is positioned below the first end and in the settling container, the fluid and the abrasive particles suspended in the fluid flowing through the conduit from the one compartment to the settling container under the influence of gravity.

14. The removal device of claim 12 wherein the fluid transport mechanism further comprises a fluid drive system coupled to the conduit, the fluid drive system driving fluid and abrasive particles suspended in the fluid through the conduit to the settling container.

15. The removal device of claim 14 wherein:

the first end of the conduit is positioned in a lower portion of the one compartment; and

the fluid drive system comprises a pressurized gas source attached to the conduit at a location below a fluid level in the one compartment, a gas from the pressurized gas source being injected into the conduit and the gas rising through at least a portion of the conduit, the rising gas drawing fluid and abrasive particles suspended in the fluid through the conduit from the one compartment to the settling container.

16. The removal device of claim 15 wherein the fluid drive system further comprises a back-flush valve in the conduit between the second end and the location of attachment of the pressurized gas source, the back-flush valve being positionable in an open position to allow fluid to flow through the conduit and a closed position to allow pressure to build in the conduit for clearing a blockage of abrasive particles from the first end of the conduit.

17. The removal device of claim 14 wherein:

the first end of the conduit is positioned in a lower portion of the one compartment; and

the fluid drive system comprises a pump attached to the conduit, the pump driving fluid through the conduit from the one compartment to the settling container.

18. The removal system of claim 17 wherein the pump comprises a diaphragm pump.

19. The removal device of claim 14 wherein:

the first end of the conduit is positioned in a lower portion of the one compartment; and

the fluid drive system comprises a motor with a drive shaft and an impeller attached to the drive shaft, the impeller being positioned with respect to the conduit to drive fluid through the conduit from the one compartment to the settling container.

20. The removal device of claim 12 wherein the tank further includes a plurality of compartments and the cutting path moves with respect to the tank to pass across at least two of the plurality of the compartments, each compartment being configured to receive the fluid and the abrasive particles from the fluid-jet as the fluid-jet passes across each compartment and to control fluid flow to an adjacent compartment, and, while the fluid-jet passes across one of the compartments, the controlled fluid flow of the one of the compartments and the fluid-jet maintaining at least a substantial portion of the abrasive particles in suspension in the fluid in the one of the compartments without additional mechanical agitation.

21. The removal device of claim 20 wherein the tank comprises a bottom panel, a side-wall projecting from the bottom panel to define a reservoir, and at least one divider in the reservoir to divide the tank into at least two compartments.

22. The removal device of claim 20 wherein the tank comprises:

a bottom panel, a first side-wall projecting from one side of the bottom panel, a second side-wall projecting from another side of the bottom panel and juxtaposed to the first side-wall, a first end-wall projecting from one end of the bottom panel, and a second end-wall projecting from another end of the bottom panel and juxtaposed to the first end-wall, the first and second end-walls being attached to the first and second side-walls; and

at least one divider extending across the tank between one of side-walls or the end-walls to divide the tank into at least two compartments.

23. The removal device of claim 22 wherein the divider comprises a baffle around which a restricted fluid flow may pass from a first compartment to an adjacent second compartment.

24. The removal device of claim 20 wherein:

the tank comprises at least a first compartment and a second compartment;

the conduit comprises at least a first conduit section and a second conduit section, the first conduit section having a first end positioned in a lower portion of the first compartment and a second end positioned in the second compartment, the second conduit section having a first end positioned in a lower portion of the second compartment and located to receive a first fluid flow from the first conduit section, and the second conduit section further including a second end open to the settling container; and

the fluid transport system further comprises a fluid drive system coupled to the first and second conduit sections, the fluid drive system driving the first fluid flow through the first conduit section from the first compartment to the second compartment, and the fluid drive system driving a second fluid flow through the second conduit section from the second compartment to the settling container.

25. The removal device of claim 24 wherein the fluid drive system comprises:

a pressurized gas source; and

a gas line coupled to the gas source, the gas line having a first segment attached to the first conduit section a location below a fluid level in the first compartment, and the gas line having a second segment attached to the second conduit section at a location below a fluid level of the second compartment, a gas from the pressurized gas source being injected into the first and second conduit sections and the gas rising through the conduit sections to draw the first and second fluid flows through the first and second conduit sections, respectively.

26. The removal device of claim 25 wherein the fluid drive system further comprises:

a first back-flush valve in the first conduit section between the second end of the first conduit section and the location of attachment of the first gas line, the first back-flush valve being positionable in an open position to allow the first fluid flow through the first conduit section and a closed position to allow pressure to build in the first conduit section for clearing a blockage of abrasive particles from the first end of the first conduit section; and

a second back-flush valve in the second conduit section between the second end of the second conduit section and the location of attachment of the second gas line, the second back-flush valve being positionable in an open position to allow the second fluid flow through the second conduit section and a closed position to

allow pressure to build in the second conduit section for clearing a blockage of abrasive particles from the first end of the second conduit section.

27. The removal device of claim 20 wherein:

the tank comprises at least a first compartment and a second compartment;

the conduit comprises a main section, a first conduit section coupled to the main section, and a second conduit section also coupled to the main section, the first conduit section having a first end positioned in a lower portion of the first compartment and a second end attached to the main section, the second conduit section having a first end positioned in a lower portion of the second compartment and a second end attached to the main section, and the main section having a discharge end open to the settling container; and

the fluid transport system further comprises a fluid drive system coupled to at least one of the first, the second and the main conduit sections, the fluid drive system driving a first fluid flow through the first conduit section from the first compartment to the main section, and the fluid drive system driving a second fluid flow through the second conduit section from the second compartment to the main section, the first and second fluid flows passing through the discharge end of the main section to the settling container.

28. The removal device of claim 20 wherein:

the tank comprises at least a first compartment and at least a second compartment;

the conduit comprises a first conduit section extending from the first compartment directly to the settling container and a second conduit section extending from the second compartment directly to the settling container, the first conduit section having a first end positioned in a lower portion of the first compartment and a second end open to the settling container, the second conduit section having a first end

positioned in a lower portion of the second compartment and a second end open to the settling container; and

the fluid transport system further comprises a fluid drive system coupled to the first and second conduit sections, the fluid drive system driving a first fluid flow through the first conduit section from the first compartment to the settling container, and the fluid drive system driving a second fluid flow through the second conduit section from the second compartment to the settling container.

29. The removal system of claim 12 wherein the settling container comprises:

a drum having a rim defining an opening of the drum; and

a detachable shroud attached to the drum, the second end of the conduit being attached to the shroud to deposit the transported portion of the fluid into the drum, and the outlet of the settling container being positioned in the shroud, wherein the abrasive particles accumulate in the drum, and when the drum is full, the shroud is removed from the drum to be placed on another empty drum.

30. A method of operating a fluid-jet cutting machine, comprising:

projecting an abrasive fluid-jet having a plurality of abrasive particles in a fluid through a work-piece and into a compartment of a tank;

maintaining a significant portion of abrasive particles in suspension in the fluid in the compartment without mechanical agitation other than the fluid-jet;

transporting a portion of the fluid with suspended abrasive particles from the compartment to a settling container; and

settling abrasive particles from the transported portion of fluid to leave an accumulation of abrasive particles in a lower portion of the settling container and a clarified liquid above the accumulation of abrasive particles in the settling container.

31. The method of claim 30 wherein transporting the fluid comprises injecting a pressurized gas into a conduit section in the compartment below a fluid level in the compartment, the injected gas rising through a portion of the conduit section to generate a fluid flow through the conduit section that draws abrasive particles out of the compartment.

32. The method of claim 30 wherein transporting the fluid comprises pumping a fluid through a conduit section to draw suspended abrasive particles out of the compartment.

33. The method of claim 30 wherein:

the fluid-jet cutting machine includes a catch tank with at least a first compartment and a second compartment, and a fluid transport system with a first conduit section having a first end in the first compartment and a second end in the second compartment, and a second conduit section having a first end in the second compartment and a second end coupled to the settling container; and

transporting the fluid comprises injecting a fluid into the first conduit section to generate a first flow and injecting a fluid into the second conduit section to generate a second flow, the first flow drawing abrasive particles from the first compartment and the second flow drawing abrasive particles from at least the second compartment.

34. The method of claim 33 wherein injecting a fluid into the conduit sections comprises:

pressurizing a gas; and

introducing the gas into the conduit sections below a fluid level.

35. The method of claim 33 wherein injecting a fluid into the conduit sections comprises pumping a liquid through the conduit sections.

36. The method of claim 30, further comprising clearing an inlet of a conduit between the compartment and the settling container of an accumulation of abrasive particles.

37. The method of claim 36 wherein clearing the conduit inlet comprises:

closing a back-flush valve in the conduit; and

injecting air into the conduit between the back-flush valve and the abrasive particle accumulation, the injected air blowing the abrasive particle accumulation from the inlet of the conduit.